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THE INFLUENCE OF LEARNING STRATEGIES IN THE ACQUISITION, RETENTION, AND TRANSFER OF A VISUAL TRACKING TASK

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task involving the same apparatus. Separate analysis for the two dependent variables, time on target and absolute error, revealed subjects displayed superior performance (in terms of both dependent variables) during the transfer task. A significant group effect for total time on target appeared to suggest that the rhythmic strategy group was superior to the control group. In general, however, no one strategy was more effective than any other or the control condition in producing learning during the acquisition, retention, or transfer phases in this experiment.

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FOREWORD

The Personnel and Training Research Laboratory of the Army Research Institute for the Behavioral and Social Sciences (ARI) conducts research to support training methods to optimize skill acquisition and retention. A variety of research is being conducted on the effects of various learning strategies on skill acquisition and retention. ARI, in cooperation with the Defense Advanced Research Projects Agency (DARPA), is especially interested in training strategies for acquisition, retention, and transfer of motor skills. This report discusses the effectiveness of learning, retention, and transfer of a visual transfer task under five different learning strategies and the implications of the findings for motor skill development. Research was conducted at Florida State University under contract MDA903-77-C-0020, which was monitored by Joseph S. Ward of ARI under Army Project 2Q161102B74F and funded by DARPA.


JOSEPH ZEIDNER
Technical Director

THE INFLUENCE OF LEARNING STRATEGIES IN THE ACQUISITION, RETENTION,
AND TRANSFER OF A VISUAL TRACKING TASK

BRIEF

Requirement:

To analyze the effectiveness of different learning strategies on initial learning, retention, and transfer of the motor skill of visual tracking.

Procedure:

Fifty college-age subjects were randomly assigned to one of five strategy conditions: imagery, rhythmic, anticipatory, informed choice, and control conditions. The task used a visual tracking apparatus and required subjects to follow a moving visible or invisible target. After the learning trials, participants were given a retention test and then a transfer task using the same apparatus.

Findings:

Analyses for time on target and for absolute error indicated superior performance for the transfer task, perhaps because of increased experience. For total time on target, the rhythmic strategy group appeared to be significantly superior to the control group. However, no single strategy produced more effective learning, possibly due to the complexity of the task to be learned in the allotted time.

Utilization of Findings:

Results suggest that tracking tasks, which involve anticipating the patterns of timing and position, require experience as well as strategies of learning.

TABLE OF CONTENTS

	Page
Introduction	1
Methods.	11
Subjects	
Apparatus	
Procedure	
Results.	17
Discussion	23
References	29
Appendix A: Instructions to Subjects.	34

LIST OF TABLES

Table	Page
1. Mean scores of significant effects for total time on target.	21
2. Mean scores for significant effects for total time on target for retention phase	24
3. Mean error scores for groups during acquisition and transfer conditions	27

LIST OF FIGURES

Figure	Page
1. The information processing characteristics of the control system used in the visual tracking apparatus.	13
2. The schematic display of the control system used in the visual tracking apparatus	15
3. Trials effect for time on visible target. . .	18
4. Trials effect for absolute error with target visible.	20
5. Trials effect for total time on target. . . .	22

*THE INFLUENCE OF LEARNING STRATEGIES IN THE ACQUISITION, RETENTION,
AND TRANSFER OF A VISUAL TRACKING TASK*

Introduction

In recent years, researchers have shown an increased interest in the cognitive processes that may primarily influence the learning of various matter. This thrust, in turn, has generated numerous approaches to examine the effectiveness of a number of learner strategies to facilitate the acquisition and retention of verbal material. To a much lesser degree, the use of strategies within the motor learning domain has been of concern.

An effective learning strategy has been defined as the simplest and most efficient means of processing the information inherent in a situation (Newell & Simon, 1972). Rigney (1978) suggested that a strategy may be interpreted as signifying operations and procedures a learner may adopt to acquire, retain, and to retrieve different kinds of information. Similarly, Bruner, Goodnow, and Austin (1956) have written that a strategy provides the learner with a pattern of decisions for the acquisition, retention and future utilization of information. Based upon an interpretation of the preceding definitions, it would appear that a strategy, or combinational strategies, developed by the learner in accordance with his/her cognitive abilities and situational demands, are effective in relating new information to previously obtained knowledge (Bruner, 1961).

Within the area of verbal learning, the use of

learner strategies has facilitated the acquisition and retention of specific information across a variety of age groups (Belmont & Butterfield, 1971; Bruner, Goodnow, & Austin, 1956; Hagen, Hargrove, & Ross, 1973; Kingsley & Hagen, 1975). Various strategies such as mnemonics, encoding, rehearsal, and labeling have proven to be effective in the acquisition and retention of information for immediate recall. Typically, experiments involve the presentation of letter lists which must be committed to memory in order to be recalled immediately following presentation. The effectiveness of particular strategies is usually assessed by the length of interim pauses during list learning (Belmont & Butterfield, 1971) and correctness of response during serial recall (Maccoby & Hagen, 1965).

In order to ascertain the effectiveness of naming or labeling stimuli during acquisition on later recall, Atkinson, Hansen, & Bernbach (1964) devised a serial recall task. Picture cards were arranged in a horizontal line and displayed one at a time to the subject. After presentation, each card was returned face down. Once four to eight cards had been shown, a cue card was presented and the subject's task was to point to the card in the series that matched the cue card. Results indicated the subjects who used a labeling strategy were able

to recall a higher percentage of pictures correctly than control subjects. Additionally, the serial order recall was better for strategy groups than for non-strategy groups. Hagan and Kingsley (1968) developed a similar paradigm in which children 4, 6, 7, 8, and 10 years of age were tested in conditions where verbal naming was either required or not required. Results indicated that with middle-age group children, labeling facilitated learning while at the youngest and oldest levels, no change in recall occurred.

Researchers have demonstrated that concrete stimuli (i.e., pictures and designs) are more easily retained than abstract verbal material (Bevan & Steger, 1971; Paivio, 1969) and that imagery appears to be a more effective mnemonic than verbal labeling in paired associate tasks using concrete noun pairs (Paivio & Foth, 1970). Similarly, when learners are instructed to imagine a mental picture formed by specific word-pairs or to use a visual image (Bower & Winzenz, 1970; Paivio & Yuille, 1969) learning is enhanced.

Although particular strategies may be more adaptable to specific tasks, the general conclusions in studies designed to determine the effectiveness of learner strategies are unequivocal. The application of appropriate mental operations which are compatible with a learner's

cognitive capabilities leads to superior performance attainment as compared to individuals who do not utilize the same strategy operations.

Learning strategies can also facilitate the storage as well as retrieval of verbal information. Several types of strategies that have been shown to promote learning are the learner's free choice of mnemonic techniques, various encoding instructions, or instructions in the use of particular strategies (Craik & Lockhart, 1972; Craik & Tulving, 1975). Although the dependent measures differ, the conclusions drawn remain similar. Strategy usage has a facilitatory effect on the acquisition and retention of information.

The implication for motor learning would appear to be that the use of strategies should facilitate the learning process. However, while there exists an abundance of supportive evidence for strategy usage within the verbal learning area, research is severely lacking within the motor learning domain. Thus, inferences must be drawn from verbal learning research as to the potential beneficial effects of various types of strategies on the acquisition and retention of motor skills.

In an attempt to apply verbal labeling strategies to a motor task, Shea (1977) required subjects to reproduce a single criterion position on a manual lever

positioning apparatus after experiencing the movement once. Of the three groups tested, one group was provided with relevant labels, one group created its own irrelevant labels, and one group had no labels. The relevant label group showed significantly higher recall scores than either of the other two groups. Additionally, no decrement in recall was observed over time (60 sec) when relevant labels were provided. Such results lend credence to the notion that a meaningful labeling strategy enhances the storage of information as well as facilitating later recall.

Similarly, Housner and Hoffman (1979) investigated the role of imagery in the reproduction of criterion points and locations. Subjects were instructed to formulate a mental picture of their hands moving to the criterion position or at the end location point. During rest intervals, some subjects were required to employ imaginal rehearsal while others were prohibited from rehearsing by the use of distractor tasks. Results indicated that those subjects who applied the imagery strategy during the movement to end locations and also during rest intervals displayed superior recall of the criterion points. Similar results were reported by Hagenbeck (1978), who investigated the effectiveness of imagery, irrelevant labeling, relevant labeling, and

kinesthetic awareness on the learning of six serial positions in a curvilinear repositioning task. However, Hagenbeck required imagery subjects to mentally picture the criterion positions as analogous to the numbers of a clock face. Of the three strategy groups, imagery was found to be most effective during reproductive movements.

Ridsdale (1978) compared chunking, overt rehearsal, forced choice, and free choice strategies and their influence on subjects attempting to learn a card sorting task. The chunking strategy was shown to be more effective for skill acquisition while free-choice (self-generated) strategies yielded better performances in retention. It would appear from data such as these that particular strategies may be appropriate with particular types of people, e.g., a strategy X cognitive style arrangement. Whether or not such a notion is tenable remains open to speculation. However, the results of preliminary investigations on the effectiveness of strategies within the motor learning domain closely parallel verbal learning findings in that individuals who are guided in their use of strategies show superior performance in relation to control groups.

Although tasks of location reproduction and card sorting require both cognitive and motor capabilities, the demands of everyday life often require individuals to

perform motor skills of far greater complexity than these tasks. Additionally, they might have to transfer knowledges and skills to new learning situations. However, while the use of cognitive strategies has been shown to facilitate the acquisition and retention of newly learned material (e.g., Campione & Brown, 1974; Kendler, 1964; Kendler & Kendler, 1962), the generalizability (transfer) of these same strategies to different situational contexts is questionable.

Still, there are those (Gagné, 1977; Singer & Gerson, in press; Wichelgren, 1974; Wittrock, 1967) who contend that rather than being oriented to specific kinds of external content, such as language or numbers, cognitive strategies are and should be, largely independent of content and apply to all types of learning conditions.

As Gagné (1977) has pointed out, the difficulty lies in arranging conditions so that transfer can be demonstrated. Strategy transfer usually cannot occur unless the initial learning environment includes some reference to the transfer situation (Bransford, Franks, Morris, & Stein, 1978; Campione & Brown, 1974), such as the temporal structuring of the components within each task being similar (Keele & Summers, 1976). Campione and Brown (1974) suggested that transfer is best when the form of the two situations remains the same. More specifically,

context may well direct one's attention toward relevant facts. A familiar problem in a new context fails to elicit any strategy since nothing in the situation cues the learner how to approach the problem. Investigations dealing with elementary children (Campione, 1973) have provided additional evidence for the context-tied problem. To overcome this circumstance, Campione (1973) suggested that when individuals learn useful problem-solving strategies, these strategies should be employed in a variety of situations so that a particular strategy is not restricted to a specific context. It would appear, then, that strategies which enhance skill acquisition and retention also have the potential to transfer to the learning of a skill in a new situation with similar parameters.

Anticipatory timing is often an important accommodating response in certain motor tasks. As Christina (1977) has suggested, the attainment of timing is contingent upon an individual's ability to employ some type of process of anticipatory interpretation in order to control the required response with regard to temporal factors. In this sense, it would appear that the use of anticipatory strategies would be invaluable when skilled motor performance is demanded.

In line with this notion, performance in pursuit tracking tasks has often been investigated in order to

discern the factors which influence perceptual anticipation. Poulton (1957) has recommended this type of task due to the variability with which target speeds, sizes, and pathways can be easily manipulated. More specifically, by visually obscuring the target during movement through selected pathways, the complexity of the task is increased. Hammerton and Tichner (1970) found significant performance differences (in terms of time on target) between groups that tracked visible targets and groups tracking targets that randomly disappeared from view.

These variations in performance, according to Flowers (1978), were indicative of the particular strategies employed to track the moving target. For example, subjects who continually watched the target and attempted to overtake it as it moved, displayed poorer performance when compared to subjects who utilized a predictive strategy to determine both the present and subsequent direction of the target during periods of target obscuration. It would appear that strategy utilization, in the absence of visual cues, enabled subjects to effectively track the moving target.

While perceptual anticipation is an integral part of many motor skills, there are two distinct types of anticipation: temporal and spatial. According to Christina,

Spatial anticipation requires that the subject learn to predict where a stimulus will appear, whereas temporal anticipation demands that he learn to predict when it will appear. (1977, p. 242)

In this sense, the temporal demand of a skill may suggest the use of some type of rhythmic strategy in order to effectively track moving targets.

Therefore, it was the purpose of the present study to analyze the effectiveness of particular strategies on the acquisition, retention, and subsequent transfer of a visual tracking task. The following strategy conditions were investigated: anticipatory, rhythmic, imagery, and informed choice.

In line with the consistent finding that strategy utilization enhances initial learning, it was hypothesized that subjects employing a particular strategy would display superior performance across all three conditions (acquisition, retention, and transfer) when compared to control subjects who used no designated strategy. Previous research in anticipatory timing (Flowers, 1978; Hammerton & Tichner, 1970; Poulton, 1952) has indicated superior performance occurs when individuals are able to effectively employ some type of anticipatory "strategy." Additionally it would appear that a rhythmic strategy may

enable the learner to adjust to temporal variations of the moving target. Therefore, it was hypothesized that subjects in the informed choice group, who employed a combination of rhythmic and anticipatory strategies, would perform better than the imagery group during acquisition and retention trials.

Although the potential for the transfer of strategies from one task to another has received little support, it would appear that transfer requires that the initial learning environment include some reference to the transfer situation (Bransford, Franks, Morris, & Stein, 1978) such as the temporal structuring of the components within each task being similar (Keele & Summers, 1976). In view of this notion it was hypothesized that during the transfer phase, subjects in the informed-choice group would, again, display superior performance.

Methods

Subjects

Male and female undergraduate and graduate students (20 males and 30 females; M age = 23.74 yrs.) from Florida State University volunteered to participate in this study.

Apparatus

The central component of the visual tracking

apparatus was a scoring and sequencing module designed and developed in the Motor Learning Laboratory at Florida State University. This electronic module sequenced each trial and transposed spatial and temporal tracking parameters into time on target and absolute error scores. Figure 1 illustrates the information processing characteristics of the control system incorporated in this experiment.

The target employed was a 2 mm green dot produced by a Southwest Technical Products function generator and displayed on a low persistence cathode ray tube oscilloscope (Tektronix, Model D54) with a screen size of 6 cm X 10 cm. A Cromemco JSI joystick module was fitted with a 4 cm metal rod which the subject moved forward or back to cause a corresponding upward or downward movement of a 1 mm tracking dot displayed on the screen of the oscilloscope. Trial time and target display time intervals were maintained by an interval timer (Lafayette, Model 5001) with periodic blanking of the displayed target waveform produced by the function generator and time interval produced by the repeat cycle timer. Time on target and absolute distance from target data for both the blanked and not blanked target display conditions were recorded by four digital clock/counters (Lafayette, Model 54119). Time on target feedback information was displayed

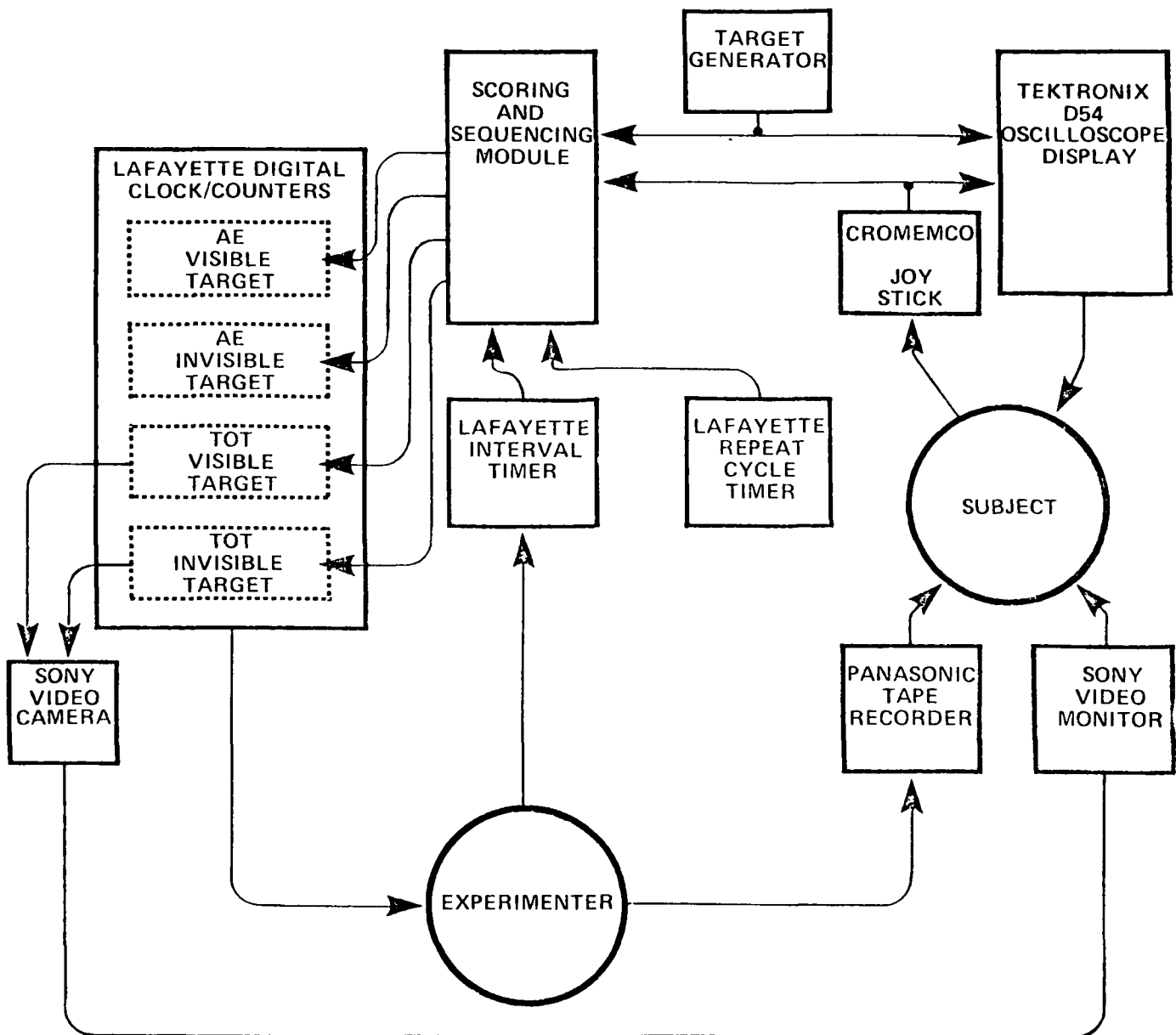


Figure 1. The information processing characteristics of the control system used in the visual tracking apparatus.

to the subject via a closed circuit video camera (Sony, AVC-3200) and monitor (Sony, Model Cum 51 WWD). An audio system consisting of a microphone (Astatic, Model 333), white noise generator (Marietta, Model 24-21-B), and a remote speaker enclosed in the joystick module was used periodically for communication between subject and experimenter. Figure 2 is an illustration of the physical placement of the apparatus utilized in this experiment.

Procedure

Each trial consisted of a 4 sec illumination of the warning light, 10 sec of tracking followed by 10 sec of KR and 15 sec digestion time (time to use the KR and apply the appropriate strategy). At the onset of each trial, both the target dot and the tracking dot appeared at the left of the oscilloscope and moved across the screen to the right. The presentation position of the target dot at the beginning of each trial was randomly distributed in order to eliminate the predictability of the starting position by subjects.

The 10 sec tracking interval was subdivided into 7 sec of visible target time and 3 sec of obscuration of the target during the invisible condition. Invisible periods were randomly distributed across both acquisition and transfer trials. Regardless of visibility, the target dot continued in the pre-set pattern.

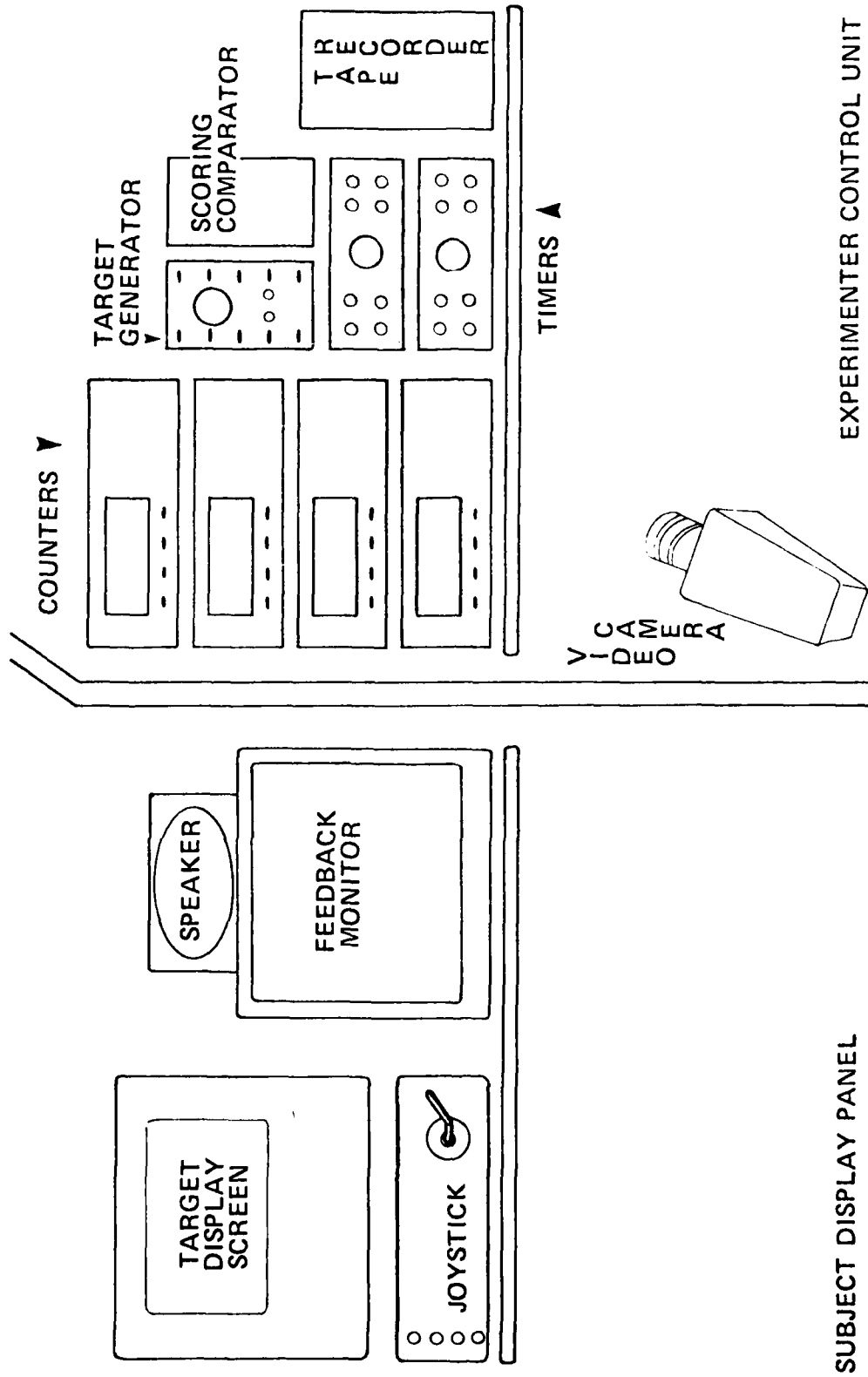


Figure 2. The schematic display of the control system used in the visual tracking apparatus.

Upon completion of the practice trial, the control group immediately received 8 acquisition trials, while strategy groups received taped instructions (see Appendix) related to their specific strategy group, followed by 8 acquisition trials. Prior to each even numbered trial, strategy groups were reminded to use their particular strategy.

Following the 8 acquisition trials a retention interval of 20 sec, in addition to the 15 sec digestion time, was used. At this time, half the subjects in each strategy group were administered a filler task which consisted of the addition of 3-digit numbers (filled retention interval) while the remaining 5 subjects in the group merely awaited the onset of the retention trial (unfilled retention interval). A retention trial was then administered. Before proceeding with the transfer task, subjects were administered a questionnaire by the experimenter in order to ascertain whether or not strategy utilization had been helped.

The experimenter then returned to the control room, changed the function generator to produce the saw-tooth wave pattern, and initialed the taped instructions for the transfer phase of the experiment. No cueing was administered to strategy groups during the transfer trials. Immediately following the final trial of the transfer

phase, the experimenter reentered the test area to administer the questionnaire.

Results

Separate 5 X 2 X 8 (strategies X tests X trials) ANOVAs, with repeated measures on the last two factors, were conducted for time on target in the two conditions (visible and invisible) and absolute error for both conditions.

ANOVA for time on target in the invisible condition (TOTI) yielded a significant main effect for test, $F(140) = 5.649$, $p < .01$, revealing that subjects were able to stay on target for longer periods of time during the transfer task ($\bar{M} = 1.19$) when compared to the acquisition task ($\bar{M} = 1.35$). ANOVA for time on target during the visible condition (TOTV) also yielded a significant main effect for task, $F(1, 40) = 54.971$, $p < .01$. Time on target during the transfer task was significantly superior ($\bar{M} = 3.92$) to that of the acquisition phase ($\bar{M} = 3.17$).

In addition to superior performance during transfer, a significant main effect for trials was obtained, $F(7, 40) = 4.742$, $p < .01$, and this learning trend is depicted in Figure 3.

ANOVA for absolute error during the invisible

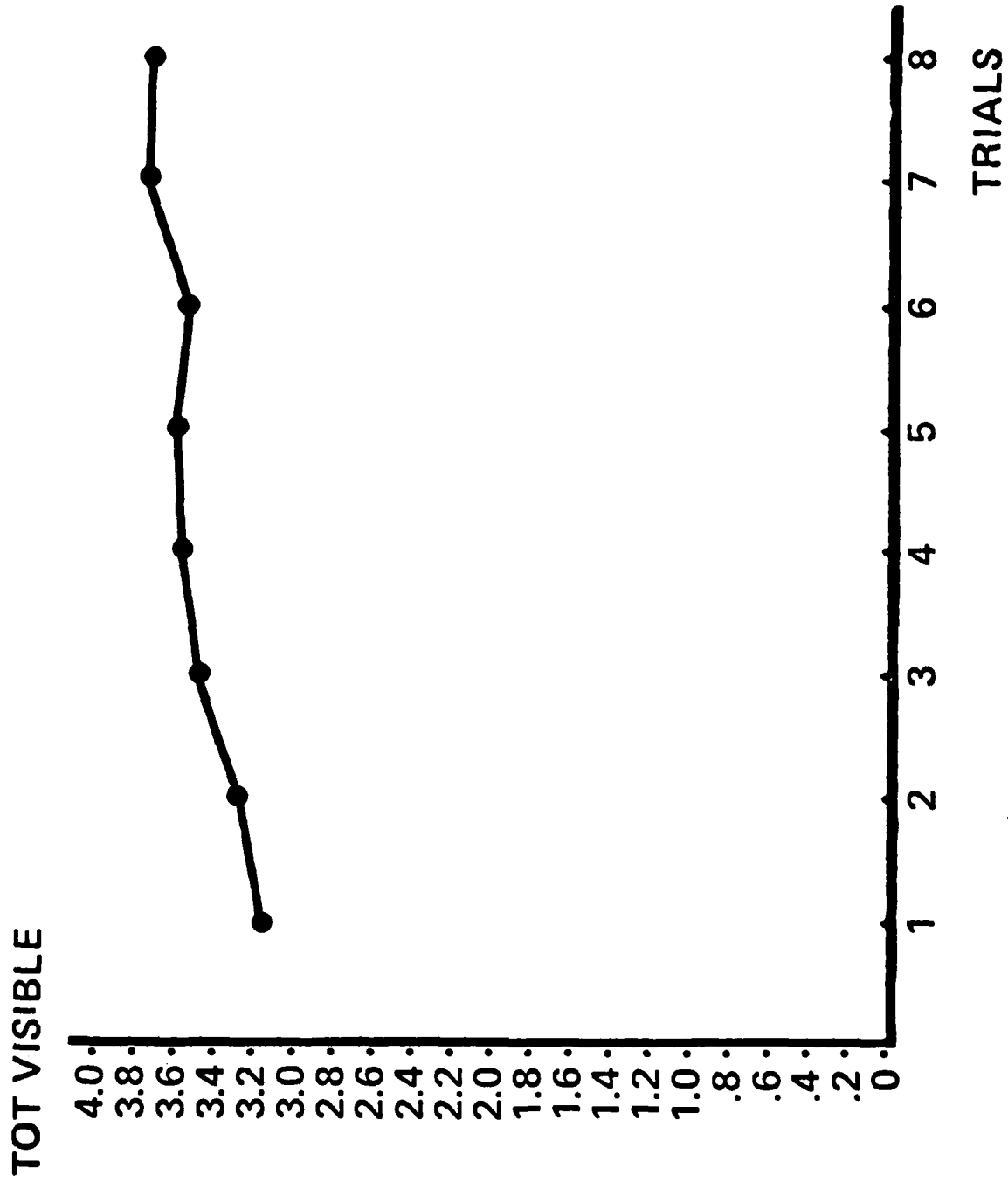


Figure 3. Trials effect for time on visible target.

condition resulted in no significance. However, during the visible target condition, a significant main effect for tests was found, $F(1, 40) = 58.261$, $p < .01$. Less errors were committed during the transfer phase ($M = 6.51$) than during the learning phase of testing ($M = 8.02$). A significant trials effect, $F(7, 40) = 2.662$, $p < .05$ was also found but the Newman-Keuls follow-up test was not sensitive enough to determine the locus of these differences. However, as can be seen in Figure 4, more errors occurred in trials 1-4 than on trials 5-8, further substantiating the learning effect shown in Figure 3.

Separate ANOVAs were conducted on total time on target and total errors. For total time on target, a significant test main effect was found, $F(1, 40) = 34.871$, $p < .01$. The means shown in Table 1 again reflect the superior tracking performance during the transfer task ($M = 5.26$) as compared to the acquisition task ($M = 4.36$). Similarly, the significant trials main effect, $F(7, 280) = 4.736$, $p < .01$, shown in Figure 5, reflects the increase in total time on target across trials.

For total errors, a significant main effect for type of test, $F(1, 40) = 26.079$, $p < .01$ was found. The mean for total errors was 14.44 in the acquisition test and 12.81 in the transfer test.

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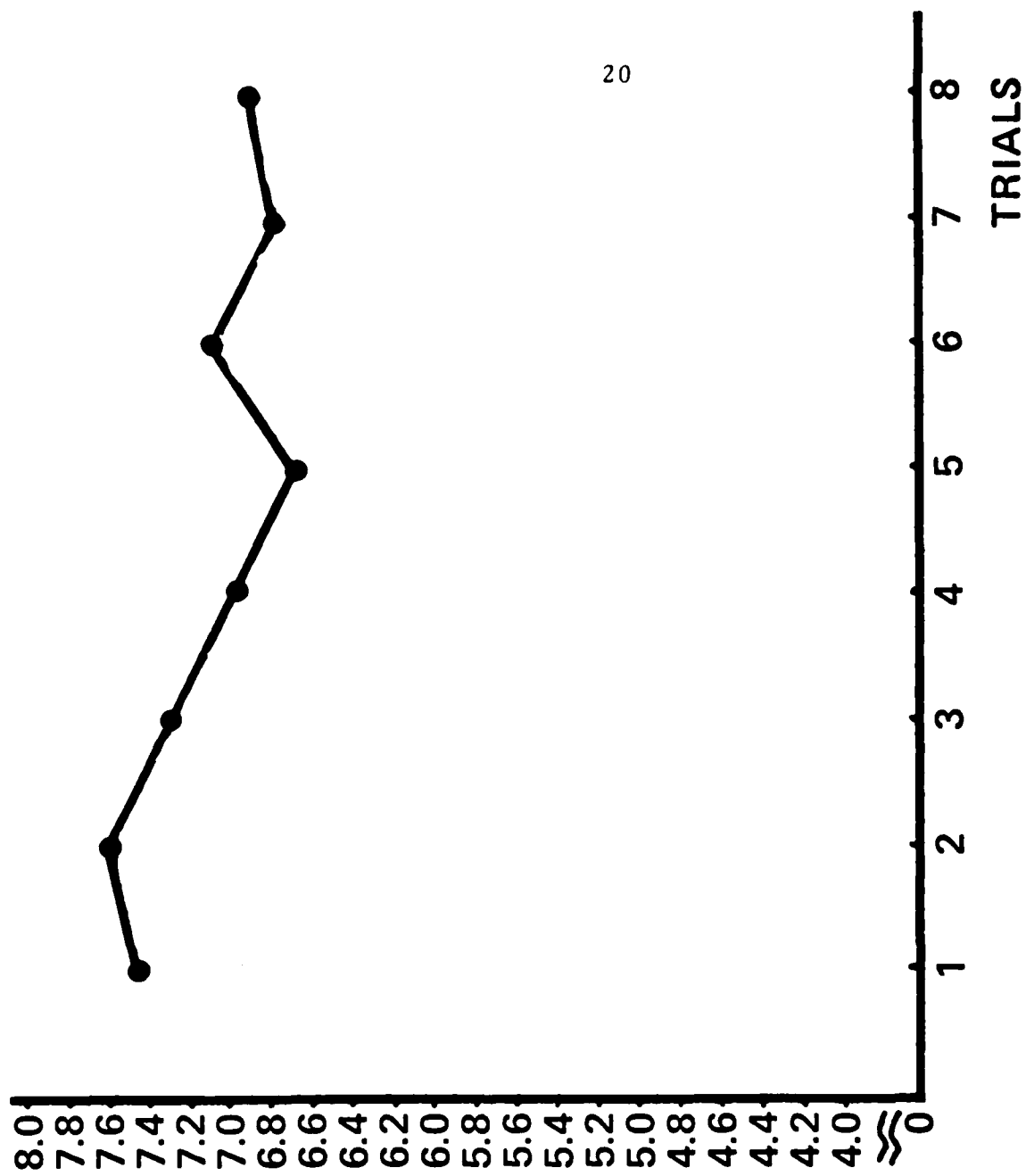


Figure 4. Trials effect for absolute error with target visible.

Table 1
Mean Scores of Significant Effects
for Total Time on Target

Tests	Acquisition	Transfer
	4.35551	5.25741

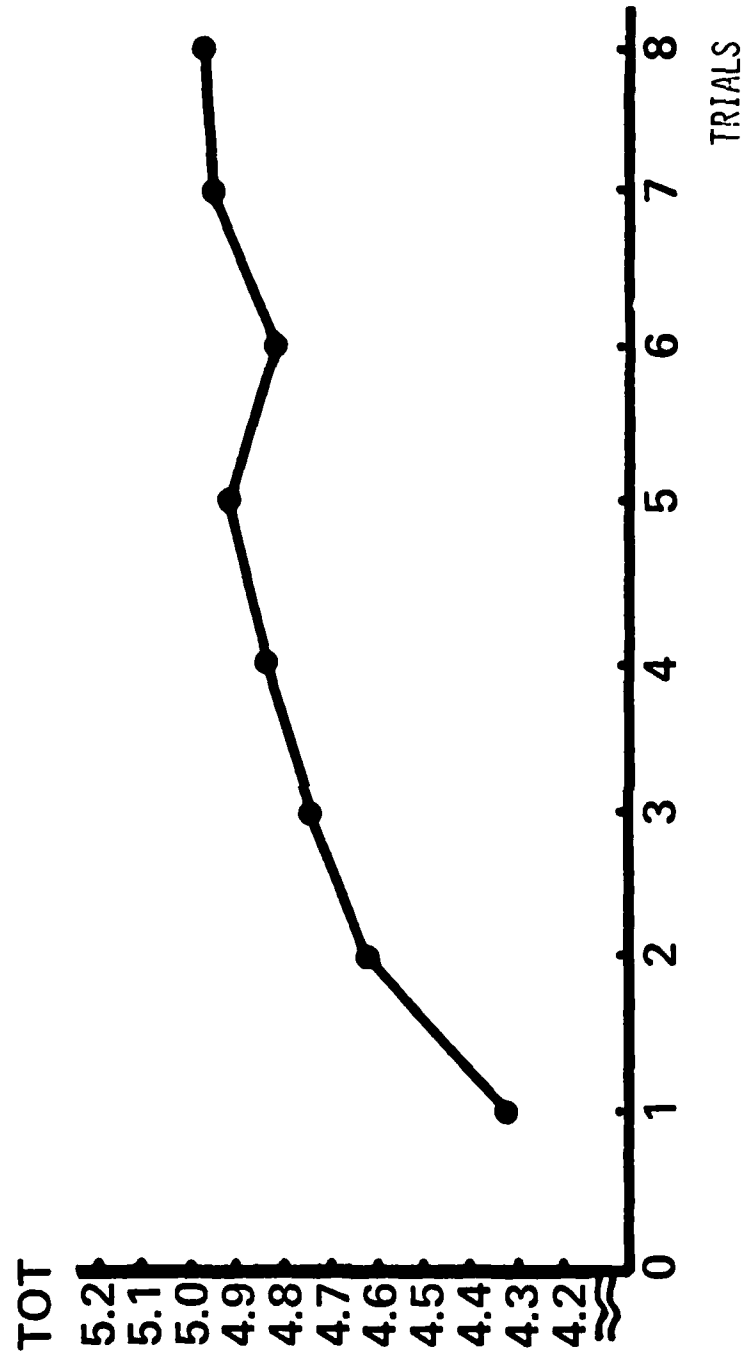


Figure 5. Trials effect for total time on target.

unfilled retention interval upon subsequent performance, a separate analysis was conducted on performance scores during the last acquisition trial and during the retention trial. Results indicated a significant group main effect for total time on target, $F(4, 40) = 3.102, p < .05$. The follow-up Newman-Keuls failed to pinpoint the locus of strategy differences. However, as can be seen in Table 2, the control group displayed the least amount of time on target while the rhythmic group displayed the longest total time on target.

Discussion

Regardless of strategy condition, subjects displayed an increased tracking ability as evidenced by the longer time on target and less errors during the transfer phase of the investigation. Such results lend credence to Schmidt's (1968) contention that anticipatory timing is a positive function of practice provided that knowledge of results accompanies performance. However, additional instruction in the use of an anticipatory strategy is of no apparent advantage, at least according to the results in the present study.

The failure to provide support for strategy effectiveness during the acquisition, retention, and subsequent

Table 2

Mean Scores for Significant Effects for Total Time
on Target for Retention Phase

Strategy	Time on Target
Control	3.96695
Imagery	4.14255
Informed Choice	4.60645
Anticipatory	4.77915
Rhythmic	5.53755

transfer of a visual tracking task may be attributable to several factors. As Christina (1977) contended, perceptual anticipation is present in tasks where the subject has no available preview of the ensuing stimuli to which he/she must respond. However, with practice, the individual learns the regularity of the pattern and in turn, utilizes this learning as a basis for future responses.

In addition, stimulus predictability has been shown to be a critical factor to the success of accurately timing responses since advance stimulus preview is not available and can only be provided by learning (Christina, 1977). It would appear tenable to suggest that the 8 acquisition trials were not sufficient enough to allow such learning to take place, a notion which can be further substantiated by the increase in tracking ability during the transfer phase, after approximately 12 continuous practice trials with the task demands. It may well be that strategy effectiveness cannot be displayed until the individual has learned to effectively anticipate both the temporal and spatial characteristics of the stimulus.

The lack of improvement in performance during the invisible target condition would appear to support such a notion. Similarly, the fact that there existed an obvious trend toward strategy effectiveness during the retention interval (as shown in Table 2)

would appear to support the notion that predictability is learned through repeated practice. It is interesting to note that both the Rhythmic and Anticipatory groups displayed superior performance during the retention phase of the investigation. Similarly, results of the group X test interaction for errors during the visible target condition (although not significant) indicated that the Rhythmic group committed the least number of errors during both acquisition ($\bar{M} = 7.16$) and transfer ($\bar{M} = 5.88$) tasks. In addition, both the Rhythmic and Anticipatory groups displayed more consistent performances across acquisition and transfer tasks than the other three groups (see Table 3). It may well be that an extension of the acquisition and transfer trials may have led to more apparent distinctions between strategy groups. Such a statement, however, remains hypothetical in view of the fact that only 8 trials were administered in the present study.

Finally, as Christina (1977) pointed out, few investigations have dealt with sequence length as an important variable in tracking tasks. In the present study, one trial consisted of a 10 sec pattern across the screen. It would appear plausible to assume that such a time limit was not long enough for subjects to derive sufficient stimulus information. In line with this notion is the finding (through questionnaire data) that various subjects

Table 3

Mean Error Scores for Groups During Acquisition
and Transfer Conditions

Acquisition		Transfer	
Rhythmic	7.162	Rhythmic	5.875
Imagery	7.687	Control	6.513
Anticipatory	7.875	Anticipatory	6.563
Informed Choice	8.163	Imagery	6.613
Control	9.200	Informed Choice	6.988

deliberately failed to track the target on preliminary trials in order to discern the pattern displayed by the moving target.

This observation points to some of the possible methodological problems with this study. A relatively simple task can be explained easily to subjects, as can the strategies to be applied to the learning of it. The task used in this experiment was fairly complex. Perhaps an insufficient amount of time was spent on providing directions to the subjects as to the nature of the task. Furthermore, it is indeed probable that more time and additional information was necessary to ensure the understanding of a particular strategy and how to use it.

When confronted with a task in which the procedural operations may be unclear and/or the strategy to be learned is not well understood, confusion will of course exist in the mind of the learner. Knowing what to do and how to do it presupposes any effective learning situation. In subsequent research, we will develop a more elaborate communication system to overcome this potential methodological problem.

REFERENCES

- Atkinson, R. C., Hansen, D. N., & Bernbach, H. A. Short term memory with young children. Psychonomic Science, 1964, 1, 225-256.
- Belmont, J. M., & Butterfield, E. C. Learning strategies as determinants of memory deficiencies. Cognitive Psychology, 1971, 2, 411-420.
- Bevan, W., & Steger, J. A. Free recall and abstractness of stimuli. Science, 1971, 172, 597-599.
- Bransford, J. D., Franks, J. J., Morris, C. D., & Stein, B. S. Some general constraints on learning and memory research. In F. I. M. Craik & L. S. Cermak (Eds.), Levels of processing and theories of memory. Hillsdale, N. J.: Erlbaum, 1978.
- Bruner, J. S. The act of discovery. Harvard Educational Review, 1961, 31, 21-32.
- Bruner, J. S., Goodnow, J. J., & Austin, G. A. A study of thinking. N. Y.: John Wiley & Sons, Inc., 1956.
- Bower, G. H., & Winzenz, D. Comparison of associative learning strategies. Psychonomic Science, 1970, 20, 119-120.
- Campione, J. C. The generality of transfer: Effects of age and similarity of training and transfer tasks. Journal of Experimental Child Psychology, 1973, 15, 407-418.
- Campione, J. C., & Brown, A. L. The effects of contextual changes and degree of component mastery on transfer

- training. In H. W. Reese (Ed.), Advances in child development and behavior. N. Y.: Academic Press, 1974.
- Christina, R. W. Skilled motor performance: Anticipatory timing. In B. B. Wolman (Ed.), International Encyclopedia of Psychiatry, Psychology, Psychoanalysis and Neurology X. N. Y.: Van Nostrand Reinhold, 1977.
- Craik, F. I. M., & Lockhart, R. S. Levels of processing: A framework for memory research. Journal of Verbal Learning and Verbal Behavior, 1972, 11, 671-684.
- Craik, F. I. M., & Tulving, E. Depth of processing and the retention of words in episodic memory. Journal of Experimental Psychology, 1975, 104, 268-294.
- Flowers, K. A. The predictive control of behavior: Appropriate and inappropriate actions beyond the input in a tracking task. Ergonomics, 1978, 21(2), 109-122.
- Gagné, R. M. Conditions of learning. N. Y.: Holt, Rinehart & Winston, 1977.
- Hagan, J. W., Hargrave, S., & Ross, W. Prompting and rehearsal in short term memory. Child Development, 1973, 44, 201-204.
- Hagan, J. W., & Kingsley, P. R. Labeling effects in short term memory. Child Development, 1968, 39, 113-121.
- Hagenbeck, F. L. Strategy utilization on the acquisition

and retention of a serial motor task. Unpublished masters thesis, Florida State University, 1978.

Hammerton, M., & Tickner, A. H. The effects of temporary obscuration of the target on a pursuit tracking task. Ergonomics, 1970, 13, 723-725.

Housner, L., & Hoffman, S. J. Imagery ability in recall of distance and location information. Paper presented at the meetings of The Canadian Society for Psychomotor Learning and Sport Psychology, Toronto, Ontario, November 1978.

Keele, S. W., & Summers, J. J. The structure of motor programs. In G. E. Stelmach (Ed.), Motor control: Issues and trends. N. Y.: Academic Press, 1976.

Kendler, T. S. Verbalization and optional reversal shifts among kindergarten children. Journal of Verbal Learning and Behavior, 1964, 3, 428-436.

Kendler, H. H., & Kendler, T. S. Vertical and horizontal processes in problem solving. Psychological Review, 1962, 69, 1-16.

Kingsley, P. R., & Hagan, J. W. Induced versus spontaneous rehearsal in short term memory in nursery school children. Developmental Psychology, 1969, 1, 40-46.

Maccoby, E. E., & Hagan, J. W. Effects of distraction upon central versus incidental recall: Developmental trends. Journal of Experimental Child Psychology,

1965, 2, 280-289.

Newell, A., & Simon, H. A. Human problem-solving.

Englewood Cliffs, N. J.: Prentice-Hall, 1972.

Paivio, A. Mental imagery in associative learning and memory. Psychological Review, 1969, 76, 241-263.

Paivio, A., & Foth, D. Imaginal and verbal mediators and noun concreteness in paired-associate learning: The elusive interaction. Journal of Verbal Learning and Verbal Behavior, 1970, 9, 384-390.

Paivio, A., & Yuille, J. C. Changes in associative strategies and paired-associate learning over trials as a function of word imagery and type of learning set. Journal of Experimental Psychology, 1969, 79, 458-463.

Poulton, E. C. On prediction in skilled movement.

Psychological Bulletin, 1957, 54, 467-478.

Ridsdale, S. The enhancement of skill acquisition through learner strategies. Unpublished manuscript, Florida State University, 1978.

Rigney, J. W. Learning strategies: A theoretical perspective. In H. F. O'Neil, Jr. (Ed.), Learning strategies I. N. Y.: Academic Press, 1978.

Schmidt, R. A. Anticipation and timing in human motor performance. Psychological Bulletin, 1968, 70, 631-646.

- Shea, J. B. Effects of labeling on motor short-term memory. Journal of Experimental Psychology, 1977, 3, 92-99.
- Singer, R. N., & Gerson, R. F. Strategies, cognitive processes, and the acquisition of skill. In H. F. O'Neil, Jr. (Ed.), Learning strategies II. N. Y.: Academic Press, in press.
- Wichelgren, W. A. How to solve problems. San Francisco: Frieman, 1974.
- Wittrock, M. C. Replacement and nonreplacement strategies in children's problem solving. Journal of Educational Psychology, 1967, 58, 69-74.

APPENDIX A: INSTRUCTIONS TO SUBJECTS

VISUAL TRACKING APPARATUS INSTRUCTIONS

Directly in front of you is a blue and white case which houses a moveable joy-stick. By moving this handle, you will be able to move a green dot on the screen in front of you. Moving the handle toward you will move the dot lower on the screen. Moving the handle away from you will move the dot higher on the screen. Leaving the handle in the middle will result in the dot being approximately in the middle of the screen. Horizontal or side to side movement of the handle will not affect the movement of your dot.

When the experiment begins, your dot and a slightly larger dot, the target, will appear at the left of the screen and move slowly from left to right across the screen to finally disappear on the right hand side. This will constitute one trial. You will receive one practice trial followed by eight learning trials with rest periods in between. During the rest periods you will be given feedback as to how well you performed. The feedback will be displayed on the video monitor to your right. (Pause--subject shown feedback display.)

The top number indicates the total time out of 10 seconds that you were on target during periods when the target was invisible. The bottom number indicates the total time out of 10 seconds that you were on target during periods when the target was visible.

Your task will be to keep your dot on the target dot as much as possible by moving the handle in front of you. At the onset of each trial, the target dot will move up and down across the screen while your dot will proceed in a horizontal path until you adjust the handle to move toward you or away from you.

You will now receive one practice trial. Remember, the target dot and your dot will appear at the left of the screen.

ANTICIPATORY STRATEGY

In some tasks, like the one you will attempt to learn here, it is important to be prepared for the unexpected. Sometimes targets move in predictable pathways, sometimes in non-predictable pathways. Sometimes they disappear momentarily, but you still need to make a movement that will allow you to track them as if they were still within your vision.

In between trials, think about anticipating the movement pattern of the target and the responses you will make. By thinking ahead, you will be able to make more appropriate responses and to score better.

IMAGERY STRATEGY

In tracking tasks, like the one you have just practiced, it will help you to image the movement of the target dot. During the task, a green target will move continuously across the screen. The path of the target will form a specific pattern. Try to make a mental picture of the pattern as a whole, rather than a simple dot moving across the screen. Imagine the target path as forming a particular pattern and also imagine the movements you need to make in tracking the moving target.

In between trials, use the imagery strategy; mentally rehearsing the pattern of the moving target and your tracking of that target.

RHYTHMIC STRATEGY

Some tasks can be performed in a smooth, rhythmic fashion. It will help you quite a bit in the present situation if you can develop a sense of rhythm as you attempt to learn the task. View the target moving across the screen and see if you can detect the regularity of its movement. As you respond and attempt to follow it, try to develop a tempo, a feeling of the rhythm necessary to track the target as it crosses the screen.

Jerky movements will be detrimental. Respond continuously, smoothly, and in rhythmic fashion. Observe accelerations and decelerations of the target, and match them when you respond during each trial. Think about this strategy in between trials.

INFORMED CHOICE

In tasks like the one you have just practiced, it is helpful to employ a particular strategy. I am going to inform you of 3 such strategies which may aid your performance of the tracking task. Listen carefully to each strategy description.

Rhythmic Strategy

Some tasks can be performed in a smooth, rhythmic fashion. It will help you quite a bit in the present situation if you can develop a sense of rhythm as you attempt to learn the task. View the target moving across the screen and see if you can detect the regularity of its movement. As you respond and attempt to follow it, try to develop a tempo, a feeling of the rhythm necessary to track the target as it crosses the screen.

Jerky movements will be detrimental. Respond continuously, smoothly, and in rhythmic fashion. Observe accelerations and decelerations of the target, and match them when you respond during each trial. Think about this strategy in between trials.

Imagery Strategy

In tracking tasks, like the one you have just practiced, it will help you to image the movement of the target dot. During the task, a green target will move continuously across the screen. The path of the target

Imagery Strategy (cont'd.)

will form a specific pattern. Try to make a mental picture of the pattern as a whole, rather than a simple dot moving across the screen. Imagine the target path as forming a particular pattern and also imagine the movements you need to make in tracking the moving target.

In between trials, use the imagery strategy; mentally rehearsing the pattern of the moving target and your tracking of that target.

Anticipatory Strategy

In some tasks, like the one you will attempt to learn here, it is important to be prepared for the unexpected. Sometimes targets move in predictable pathways, sometimes in non-predictable pathways. Sometimes they disappear momentarily, but you still need to make a movement that will allow you to track them as if they were still within your vision.

In between trials, think about anticipating the movement pattern of the target and the responses you will make. By thinking ahead, you will be able to make more appropriate responses and to score better.

You have just been informed of 3 strategies that you might use to learn this task effectively; rhythmic strategy, imagery strategy, and anticipatory strategy. Feel free to use any one or combination of strategies that you wish, or disregard all of them. However, the use of a particular strategy should help you learn the task.

CONTROL GROUP

Receives general instructions as per other groups
but no additional strategy tape after practice trial.

Transfer Instructions

You have just been tested on phase I of the task. You will now undertake a second task which will require you to follow a different pattern on the screen. You will receive one practice trial which will be administered in the same manner as the previous task. After each trial, your feedback will again be displayed on the video monitor.

Once again, please try to do the best you can on the practice trial and 8 subsequent trials, keeping your dot as close to the target dot as possible.